Dynamic MRI of the pelvic floor: comparison of performance in supine vs left lateral body position

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Abstract: OBJECTIVE To investigate the performance of MR-defecography (MRD) in lateral body position as an alternative to supine position. METHODS 22 consecutive patients (16 females; mean age 51 ± 19.4) with obstructed defecation and 20 healthy volunteers (11 females; mean age 33.4 ± 11.5) underwent MRD in a closed-configuration 3T-MRI in supine and lateral position. MRD included T weighted images at rest and during defecation after filling the rectum with 250 ml water-based gel. Measurements were performed in reference to the pubococcygeal line and grade of evacuation was assessed. Image quality (IQ) was rated on a 5-point-scale (5 = excellent). RESULTS In patients grades of middle and posterior compartment descent were similar in both body positions ($p > 0.05$). Grades of anterior compartment descent were significantly higher in lateral position (21/22 vs 17/22 patients with normal or small descent, $p < 0.034$). In volunteers grades of descent were similar for all compartments in supine and lateral position ($p > 0.05$). When attempting to defecate in supine position 6/22 (27%) patients showed no evacuation, while in lateral position only 3/22 (14%) were not able to evacuate. IQ in patients was equal at rest (4.4 ± 0.5 and 4.7 ± 0.6, $p > 0.05$) and slightly better in supine compared to the lateral position during defecation (4.5 ± 0.4 vs 3.9 ± 0.9, $p < 0.017$). IQ in volunteers was equal in supine and lateral position ($p > 0.05$). CONCLUSION In lateral position, more patients were able to evacuate with similar grades of pelvic floor descent compared to supine position. MRD in lateral position may be a valuable alternative for patients unable to defecate in supine position. Advances in knowledge: In lateral position, more patients were able to evacuate during MRD. MRD in lateral position may be an alternative for patients unable to defecate in supine position.

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FULL PAPER

Dynamic MRI of the pelvic floor: comparison of performance in supine *vs* left lateral body position

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Objective: To investigate the performance of MR-defecography (MRD) in lateral body position as an alternative to supine position.

Methods: 22 consecutive patients (16 females; mean age 51 ± 19.4) with obstructed defecation and 20 healthy volunteers (11 females; mean age 33.4 ± 11.5) underwent MRD in a closed-configuration 3T-MRI in supine and lateral position. MRD included T_2 weighted images at rest and during defecation after filling the rectum with 250 ml water-based gel. Measurements were performed in reference to the pubococcygeal line and grade of evacuation was assessed. Image quality (IQ) was rated on a 5-point-scale (5 = excellent).

Results: In patients grades of middle and posterior compartment descent were similar in both body positions ($p > 0.05$). Grades of anterior compartment descent were significantly higher in lateral position (21/22 *vs* 17/22 patients with normal or small descent, $p < 0.034$). In volunteers grades of descent were similar for all compartments in supine and lateral position ($p > 0.05$). When attempting to defecate in supine position 6/22 (27%) patients showed no evacuation, while in lateral position only 3/22 (14%) were not able to evacuate. IQ in patients was equal at rest (4.4 ± 0.5 and 4.7 ± 0.6, $p > 0.05$) and slightly better in supine compared to the lateral position during defecation (4.5 ± 0.4 *vs* 3.9 ± 0.9, $p < 0.017$). IQ in volunteers was equal in supine and lateral position ($p > 0.05$).

Conclusion: In lateral position, more patients were able to evacuate with similar grades of pelvic floor descent compared to supine position. MRD in lateral position may be a valuable alternative for patients unable to defecate in supine position.

Advances in knowledge: In lateral position, more patients were able to evacuate during MRD. MRD in lateral position may be an alternative for patients unable to defecate in supine position.

INTRODUCTION

Chronic constipation affects up to 27% of the general population, with female gender, central obesity and age as risk factors.[1] One reason for chronic constipation is an obstructed defecation (OD) which can result from many underlying disorders such as paradoxical contraction of the puborectalis muscle, impaired abdominal and rectal pushing effort or anatomical abnormalities of the pelvic floor.[2–5] Clinical evaluation of this patient population is complex and requires multidisciplinary management. The diagnostic algorithm according to Rome IV diagnostic criteria[6] includes functional tests such as anorectal manometry, tests of evacuation like the balloon expulsion test (BET), and imaging of the pelvic floor. For imaging, magnetic resonance defecography (MRD) has become a widely accepted diagnostic tool allowing assessment of pelvic floor anatomy as well as a functional assessment of evacuation.[2,7–10] Most institutions perform MRD in a closed configuration MRI scanner in supine position. For practical purposes, the defecation phase is often excluded, even though it has been shown that the defecation phase yields important additional information on the presence and degree of pelvic floor abnormalities.[11–13] Further, in pelvic floor abnormalities such as OD, parameters assessed

on defecography such as delayed initiation of evacuation, impaired evacuation and prominence of puborectalis are relevant findings.[2,14–16]

When evaluating the defecation process, the ideal body position for functional tests and for imaging has to be taken into account. The physiologic body position would be the sitting position, which has been used in MRD in open configuration MR systems, but this is not widely practiced.[17] As sitting MR systems are not widely available, MRD is mostly performed in closed configuration MR systems in supine lying position, which yield similar results for pelvic floor descent.[18] Concerning the influence of body position, Rao et al showed that in the supine, lying position approximately one-third of patients showed dyssynergia on anorectal manometry and more than one-half could not complete the BET nor the silicone stool test (FECOM).[19] This observation may be also true for MRD in the supine, lying position. Alternatively, MRD can be performed in the left lateral position, which is the usual position for anorectal manometry.[20]

In this study, we tested the null hypothesis that position has no effects on MRD assessment of pelvic floor abnormalities and defecation. The purpose of the study was to investigate the performance of MRD in lateral body position as an alternative to supine position and assess differences in pelvic floor measurements and success rate. In addition, the image quality (IQ) and patients' preference regarding position was evaluated.

METHODS AND MATERIALS

Study population

The local ethics committee approved this prospective study, and all patients gave written informed consent (Clinical trial registration number: NCT02633592).

22 consecutive patients (16 females, 6 males; mean age 51 ± 19.4) with obstructive defecation were included. Inclusion criteria were symptoms of OD (Cleveland Clinic Constipation Score >10[21]), no underlying structural diseases (*e.g.* neoplasm, inflammatory bowel disease, rectal prolapse) as proven by endoscopy and proctoscopy, age between 18–75 years.

20 healthy volunteers (11 females, 9 males; mean age 33.4 ± 11.5) were included as a control group. Healthy volunteers were included if symptoms of constipation or faecal incontinence were absent as defined by a Cleveland Clinic Constipation Score[14] of ≤10 and a Wexner Incontinence Score[15] of ≤5, respectively. Healthy volunteers between 18 and 75 years were included.

Patients and healthy volunteers were recruited between December 2014 and July 2015 (duration: 8 month). Females were eligible to participate either if physiologically incapable of becoming pregnant or with a negative urine pregnancy test at screening. Exclusion criteria were general contraindications to MRI (*e.g.* non-MR-compatible implants, claustrophobia).

MRI defecography

MRD was performed in a closed configuration 3.0 T MRI system (Skyra, Siemens Healthcare, Erlangen, Germany) with an 18-channel array coil. A dynamic true fast imaging with steady-state free precession (TrueFISP) sequence (repetition time/echo time, 1002/2.4 ms; flip angle, 40°; section thickness, 10 mm with no interslice gap; bandwidth, 600 Hz; rectangular field of view, 26 cm; matrix, 320 × 288, number of averages: 1, temporal resolution: 1 s) was obtained in the midsagittal plane at rest and during defecation. Imaging at rest and during defecation was once performed in the supine position with a pillow under knees and calves and once in left lateral position. For each position, the rectum was filled via a rectal tube with 250 ml water based gel (Ultrasonic, Skintact, Innsbruck, Austria). In case of partial emptying, the amount of the gel for the refilling of the rectum was adapted to the residual amount of the rectal filling in approximation. The amount of the retained enema was checked on the images right after the defecation phase on the scanner.

Questionnaire

After MRD patients and volunteers were asked to fill out a questionnaire answering the following questions: Was the examination in supine body position uncomfortable for you? Was the examination in left lateral body position uncomfortable for you? The answers were given on a visual analogue scale from 1 to 10, where 1 was "not at all uncomfortable" and 10 was "very uncomfortable". In addition, patients and volunteers chose their preferred body position.

MRD image analysis

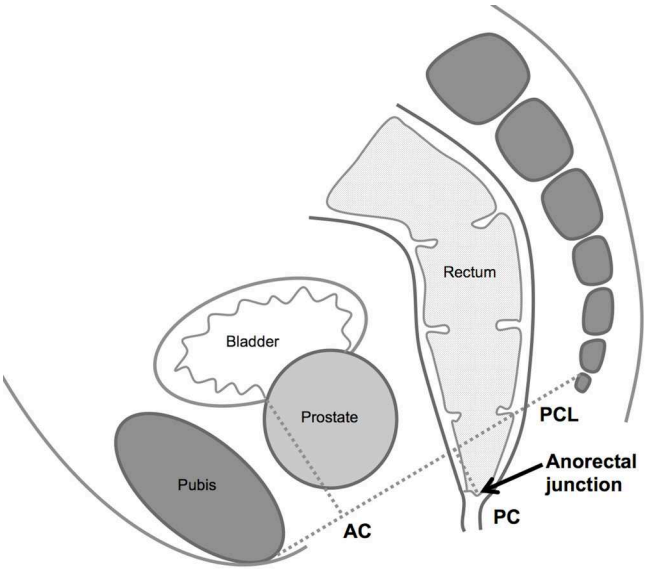
Dynamic pelvic floor MR images in the midsagittal plane were evaluated by two blinded readers (Reader 1: 9 years and Reader 2: 3 years of experience in pelvic MRI) on a commercial Picture archiving and communication system workstation in separate reading sessions. Readers first evaluated MR images in supine position, and after a delay of 3 weeks MR images in lateral position to minimize recall bias. The position of the anterior, the middle and the posterior pelvic floor compartments referring to the pubococcygeal line (PCL) were measured at rest and during defecation in supine and left lateral body position to evaluate the degree of pelvic floor descent.[22] The middle compartment which is represented by the position of the vaginal fault is missing in male participants (Figure 1). Measurements below the PCL were marked positive, measurements above the PCL were marked negative. The pelvic floor descent was graded with the grading system used by Hetzer et al.[23]

Furthermore, the grade of evacuation (GE) was assessed in both body positions and graded as unable to expel any contrast enema during the defecation phase (Grade 0), evacuation of less than 2/3 of the contrast enema (Grade 1) and evacuation of more than 2/3 (Grade 2).[2] Group 0 and 1 were considered having impaired evacuation ability.[2] The presence of intrarectal and intraanal intussusception during defecation was assessed. In cases of disagreement on GE and intussusception, the two readers performed a separate consensus reading.

Image quality

IQ of MRD in supine and left lateral position at rest and during defecation was rated on a 5-point scale, where Grade 5 was excellent IQ, Grade 4 good, Grade 3 moderate, Grade 2 acceptable

Figure 1. Schematic drawing of a sagittal male pelvis showing compartment subdivision in male participants into AC and PC by drawing a perpendicular line from the PCL to the bladder base and anorectal junction, respectively. Note that the middle compartment is missing. AC, anterior compartment; PC, posterior compartment; PCL, pubococcygeal line.



and Grade 1 poor IQ. For IQ assessment artefacts potentially hampering image interpretation were considered. Main factors considered were movement, artefacts due to air in the bowel lumen, and visibility of pelvic floor organs in midsagittal plane. The definition of the IQ grades was as follows: Excellent: No movement, no susceptibility artefact through air in the bowel lumen, all compartments in imaging plane. Good: Minor movement, minor susceptibility artefacts through air in the bowel lumen not affecting the reference structures, one compartment not exactly in midline imaging plane, image interpretation not affected. Moderate: Moderate movement artefacts and moderate susceptibility artefacts through air in the bowel lumen not affecting the reference structures, one or two compartments not exactly in midline imaging plane, image interpretation not affected. Acceptable: Major movement artefacts and major susceptibility artefacts through air in the bowel lumen not affecting the reference structures, two or three compartments not exactly in imaging plane and exact delineation of the pelvic floor organ is impaired, image interpretation not affected. Poor: Severe movement artefacts and severe susceptibility artefacts through air in the bowel lumen affecting the reference structures or no compartment in imaging plane, image interpretation affected.

A grading scale from 0 to 3 was used to assess whether all compartments and the reference point (bladder base, vaginal vault, anorectal junction) were visible in the imaging plane: 3 = all compartments in imaging plane, 2 = 2 of 3 compartments in imaging plane, 1 = 1 of 3 or 1 of 2 compartments in imaging plane and 0 = 0 compartments in imaging plane. The posterior compartment was also rated separately by verifying if it was correctly visible in the midline (1 = yes, 0 = no).

Statistical analysis

Descriptive statistics were performed for all quantitative measurements at rest and during defecation in supine and lateral body position. All quantitative variables were summarized with mean values and standard deviation. Categorical data were given as means or medians when applicable.

Interreader agreement for quantitative measurements was analysed with the intraclass correlation coefficient (ICC). Interreader agreement of categorical data (GE and presence of intussusception) was analyzed with kappa (κ) statistics. A κ-value of 0.00 was interpreted as no agreement, 0.01–0.20 as slight agreement, 0.21–0.40 as fair agreement, 0.41-0-60 as moderate agreement, 0.61-0-80 as good agreement, and 0.81–1.00 as excellent agreement.[24]

For comparison of results in supine and lateral body position, the Wilcoxon signed-rank test or the independent Student's *t*-test, where applicable, was used. The level of statistical significance was set at $p < 0.05$. Statistical analyses were performed with commercially available SPSS software v. 22.0.0.0 (IBM Corporation, Armonk, NY).

Table 1. Patients: position of compartments in supine and lateral positions at rest and during defecation relative to the PCL*

	Patients supine			Patients lateral			*p*-value
	n	Mean ± SD (mm)	ICC	*n*	Mean ± SD (mm)	ICC	
Position of compartments at rest:							
Anterior	22	-24.3 ± 11.7	0.981	22	-26. 1 ± 11.5	0.984	0.051
Middle	16	-39.6 ± 12.3	0.828	16	-36.7 ± 11.2	0.933	0.134
Posterior	22	21.0 ± 13.2	0.981	22	13.4 ± 10.9	0.946	**0.000**
Position of compartments at defecation:							
Anterior	22	4.6 ± 23.1	0.985	22	9.6 ± 24.6	0.960	**0.042**
Middle	16	2.1 ± 26.3	0.600	16	8.5 ± 23.6	0.968	**0.034**
Posterior	22	46.7 ± 15.1	0.933	22	49.3 ± 10.3	0.873	0.135

ICC, intraclass correlation coefficient; PCL, pubococcygeal line; SD, standard deviation;
*negative values indicate position above PCL, positive values indicate position below.

Table 2. Volunteers: position of compartments in supine and lateral positions at rest and during defecation relative to the PCL*

	Volunteers supine			Volunteers lateral			*p*-value
	n	Mean ± SD (mm)	ICC	*n*	Mean ± SD (mm)	ICC	
Position of compartments at rest:							
Anterior	20	−30.3 ± 7.6	0.965	20	−28.5 ± 6.7	0.863	0.409
Middle	11	−47.1 ± 5.8	0.861	11	−41.0 ± 7.6	0.664	**0.027**
Posterior	20	12.1 ± 7.7	0.977	20	7.5 ± 6.8	0.680	0.054
Position of compartments at defecation:							
Anterior	20	−6.1 ± 17.2	0.980	20	−4.1 ± 17	0.941	0.702
Middle	11	−8.2 ± 19.4	0.919	11	−1.7 ± 18.9	0.784	0.438
Posterior	20	31.4 ± 14.8	0.880	20	29.1 ± 18.9	0.762	0.667

ICC, intraclass correlation coefficient; PCL, pubococcygeal line; SD, standard deviation;
*negative values indicate position above PCL, positive values indicate position below PCL.

RESULTS

Patients

The mean score on the visual analogue scale for comfort during the examination in supine body position was 3.5 ± 2.8 (median, score 4) and for lateral body position was 4.2 ± 3.3 (median, score 5) (p = 0.151). When asked to choose, 12 patients preferred the supine position, whereas 6 preferred the lateral position with 4 patients having no preference (p = 0.067).

Volunteers

The mean score on the visual analogue scale for comfort during the examination in supine body position was 3.3 ± 2.7 (median, score 2.5) and for lateral body position was 2.4 ± 1.7 (median, score 2) (p = 0.195). When asked to choose, 8 volunteers preferred the supine position, whereas 12 preferred the lateral position (p = 0.371).

MRD interreader agreement

Interreader agreement for pelvic floor measurements in supine body position was excellent for the anterior and posterior compartment (ICC between 0.83 and 0.98) and moderate to excellent for middle compartment (ICC 0.6–0.919) at rest and during defecation in patients and volunteers. For the lateral body position, interreader agreement was excellent (ICC between 0.87 and 0.98) in all pelvic floor compartments at rest and during defecation in the patients group and moderate to excellent (0.664–0.941) in all pelvic floor compartments at rest and during defecation in the volunteers group (Tables 1 and 2).

Interreader agreement for GE was good to excellent in supine body position and moderate to excellent in lateral body position (κ-value, 0.76–0.821 and 0.50–0.834, respectively). For the presence of intrarectal and intraanal intussusception, interreader agreement was fair in supine and in lateral body position for the patients group (κ-value, 0.34–0.41 and 0.30–0.32, respectively) and moderate to excellent for the volunteers group (κ-value, 0.621–1.0 and 0.737–0.905, respectively).

MRD findings in supine *vs* left lateral position

Compartment descent

Patients

At rest the posterior compartment was significantly lower in the supine position compared to the lateral position ($p < 0.05$). The position of the anterior and middle compartment was similar in supine and lateral position at rest (p = 0.785) (Figure 2).

During defecation, the position of the anterior and middle compartment was significantly higher in supine than in lateral body position (p = 0.042 and p = 0.034, respectively). The position of the posterior compartment was similar in lateral compared to supine position during defecation (p = 0.123).

Volunteers

The position of the anterior and posterior compartment was similar in supine and lateral position at rest and during defecation

Figure 2. A 55-year-old woman with obstructed defecation and MR defecography in supine and lateral body position. The PCL is drawn from the inferior border of the pubic symphysis to the last coccygeal joint. For each participant, the maximum distance of the bladder base (AC), the position of the vaginal vault (MC), and anorectal junction (PC) was measured at 90° to the PCL. In this patient, measurements of pelvic floor descent were similar in supine and lateral body position (AC: 29 *vs* 32 mm, MC: 11 *vs* 27 mm. PC: 62 *vs* 59 mm). AC, anterior compartment; MC, middle compartment; PC, posterior compartment; PCL, pubo coccygealline.

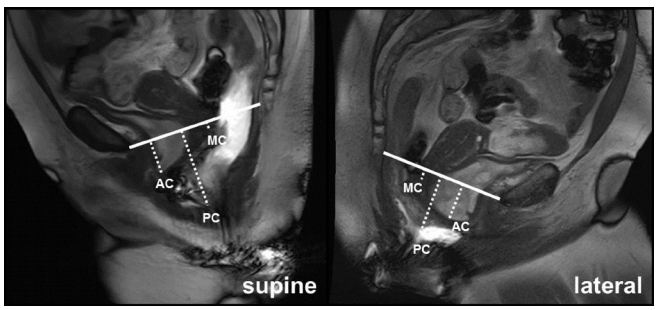


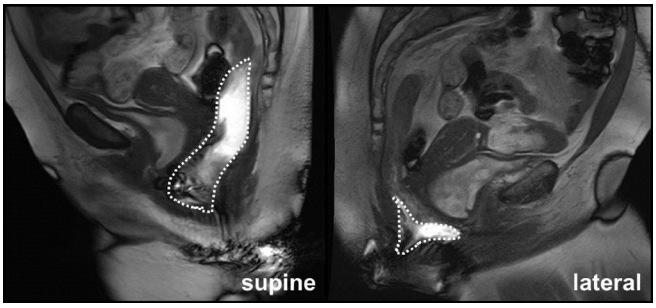
Table 3. Grade of pelvic floor descent and grade of evacuation during defecation in supine and left lateral body position

Grade of pelvic floor descent[a]	Patients[b] (n = 22)		p-value[c]	Volunteers[b] (n = 20)		p-value[c]
	Supine	Lateral		Supine	Lateral	
Anterior compartment descent:						
None	9	6	**0.034**	13	12	0.747
Small	12	11		7	8	
Moderate	1	5		0	0	
Large	0	0		0	0	
Middle compartment descent:						
None	7	7	0.157	6	6	1.000
Small	8	6		5	5	
Moderate	1	3		0	0	
Large	0	0		0	0	
Posterior compartment descent:						
None	0	0	0.180	0	0	0.877
Small	3	2		10	10	
Moderate	13	18		10	9	
Large	6	2		0	1	
Grade of evacuation						
>2/3 evacuation	13	14	0.157	11	9	0.502
< 2/3 evacuation	3	5		7	8	
No evacuation	6	3		2	3	

[a]Grading according to Hetzer et al.[23]
[b]Absolute numbers of patients.
[c]Mann–Whitney *U*-test comparing grades of pelvic floor descent between supine and lateral body position.

(rest: p = 0.409, p = 0.054 and defecation: p = 0.702, p = 0.667, respectively). At rest, the middle compartment was significantly lower in supine position compared to lateral position (p = 0.027). During defecation the position of the middle compartment was similar in supine and lateral position (p = 0.438).

Figure 3. A 55-year-old woman with obstructed defecation shows an almost empty rectum after the defecation phase in lateral position whereas in supine position 2/3 of the contrast enema are left in the rectum. The two readers rated image quality equal (IQ-score: 5 supine, 5 lateral) and the posterior compartment was in plane in both body positions. IQ, image quality.



Grade of pelvic floor descent

Patients

The grading of pelvic floor descent in supine and left lateral position is shown in Table 3. The grade of the middle and posterior compartment descent was similar in both body positions (p > 0.05). The anterior compartment showed significant difference in grade of descent between the two body positions with only 1/22 patient with a moderate anterior compartment descent in the supine position and 5/22 patients with moderate descent in the lateral position (p < 0.034).

Volunteers

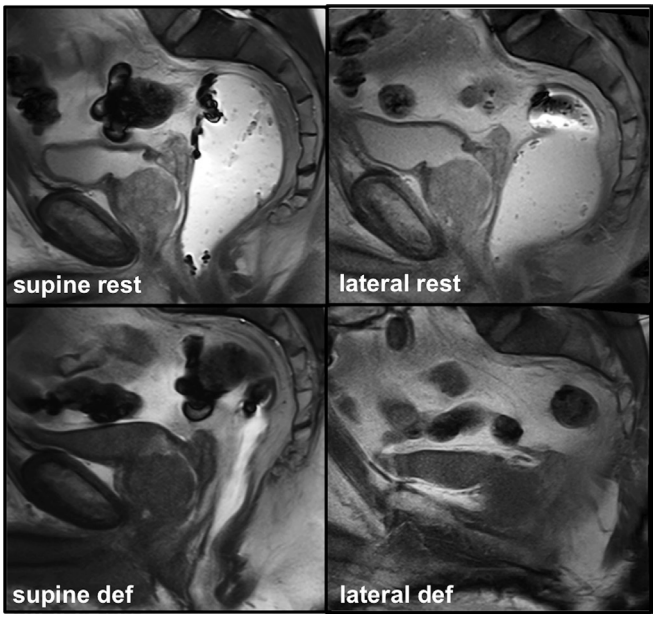
The grade of anterior, middle and posterior compartment descent was similar in supine and lateral position (p > 0.05).

Grade of evacuation and presence of intussusception

Patients

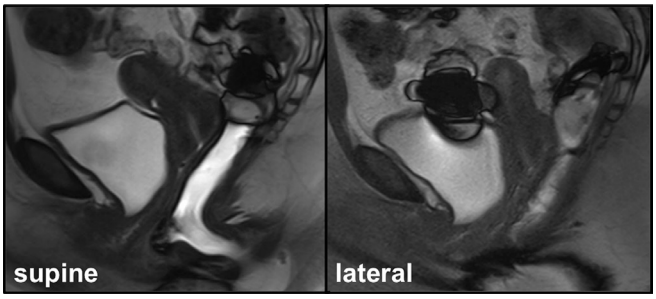
Most of the patients could expel more than 2/3 of the contrast enema in the supine and lateral body positions (13/22, (59 %) *vs* 14/22 (64 %)). Less than 1/3 of the contrast enema was expelled by 3/22 (14%) in the supine *vs* 5/22 (23%) in the lateral position. No evacuation was seen in the supine and lateral body positions for 6/22 (27%) *vs* 3/22 (14%) patients (Figure 3). The differences

Figure 4. A 66-year-old male patient shows excellent image quality in supine and lateral body position at rest with the two compartments in imaging plane, no movement artefacts or artefacts due to air in the bowel lumen. During defecation in lateral body position the image quality is degraded as the two compartments move out of the imaging plane due to tilting of the pelvis during the evacuation process in lateral position However, as in the cine acquisition some images showed both compartments in imaging plane, image interpretation was not affected (acceptable image quality Grade 2, compartments in imaging plane Grade 0).



in GE between supine and lateral body position were not statistically significant ($p = 0.157$). Intrarectal and intraanal intussusception were identified in 3/22 and 2/22 patients in supine and in 3/22 and 1/22 patients in lateral position ($p = 0.618$ and 0.928, respectively).

Figure 5. A 55-year-old female with obstructed defecation and MR defecography in supine and lateral body position. The PCL is drawn from the inferior border of the pubic symphysis to the last coccygeal joint. For each participant, the maximum distance of the bladder base (AC), the position of the vaginal vault (MC), and anorectal junction (PC) was measured at 90° to the PCL. In this patient, measurements of pelvic floor descent were similar in supine and lateral body position (AC: 29 *vs* 32 mm, MC: 11 *vs* 27 mm. PC: 62 *vs* 59 mm). AC, anterior compartment; MC, middle compartment; PC, posterior compartment; PCL, pubococcygealline.



Volunteers

In the control group, about half of the volunteers could expel more than 2/3 of the contrast enema in supine and lateral body position (11/20, (55%) *vs* 9/11 (45%), $p = 0.502$). Less than 1/3 of the contrast enema was expelled by 7/20 (35%) in the supine *vs* 8/20 (40%) in the lateral position. No evacuation was seen in supine and lateral body position for 2/20 (10%) *vs* 3/20 (15%). The differences in GE between supine and lateral body position were not statistically significant ($p = 0.502$). Intrarectal and intraanal intussusception were identified in 1/22 and 0/22 volunteers in supine and in 1/22 and 1/22 volunteers in lateral position.

MRD image quality in supine vs left lateral position

Patients

The IQ at rest was rated good to excellent in supine position and moderate to excellent in lateral position (4.4 ± 0.5 *vs* 4.7 ± 0.6, $p = 0.071$). In none of the cases IQ was rated poor.

A significant difference in the IQ was observed during defecation as the IQ was better in the supine position with IQ ratings between moderate and excellent of which only one was scored as moderate. In the lateral position, the IQ ratings were acceptable to excellent with one scored as acceptable IQ (4.5 ± 0.4 *vs* 3.9 ± 0.9, respectively; $p < 0.017$). In one patient with only acceptable IQ in lateral position all compartments moved out of the imaging plane, and therefore the delineation of the pelvic floor organs was impaired. However, the measurements of the pelvic floor descent were not hampered as in the cine acquisition some images showed the compartments in imaging plane (Figures 4 and 5).

Regarding the position of the tree compartments of the PCL system in the imaging plane and the position of the posterior compartment, there was no difference for the different body positions at rest and during defecation ($p > 0.05$) (Table 4).

Volunteers

The IQ at rest was rated good to excellent in supine and lateral position (both 4.6 ± 0.6, $p = 0.897$). In none of the cases IQ was rated poor.

The IQ at defecation was rated moderate to excellent in supine position and in lateral position (4.38 ± 0.56 *vs* 4.16 ± 0.73, $p = 0.064$)(Figure 5).

Regarding the position of the tree compartments of the PCL system in the imaging plane, there was no difference for the different body positions at rest and during defecation ($p > 0.05$) (Table 4).

DISCUSSION

This prospective study demonstrates that MRD performed in supine and lateral body position showed similar grades of middle and posterior pelvic floor compartment descent during defecation; however, more patients were able to evacuate in lateral position compared to supine body position. 20 volunteers were

examined as a control group and showed also similar grades of pelvic floor descent during defecation and similar IQ in supine and lateral body position.

The aim of MRD is to document pelvic floor anatomy at rest, during straining and defecation. The evacuation phase is of key importance in MRD especially in patients with OD because the Rome IV criteria defining functional defecation disorders include symptoms of chronic constipation with the presence of inadequate evacuation on investigation (*i.e.* balloon evacuation or imaging).[8] Therefore, the assessment of the GE is of crucial importance in this patient group.[2,14,15] Furthermore, additional and more pronounced pelvic floor abnormalities are detected during evacuation on MRD compared to the straining phase.[11,12] Notwithstanding the above, for practical reasons the evacuation phase is often excluded in MRD performed in closed configuration MRI in supine position and replaced by the straining phase to evaluate the pelvic floor descent and simulate the defecation process.[25–27]

The MRD can be accomplished either in a sitting position in an open configuration MR system[17,28] or in a lying position in a closed configuration MR system.[27,29] We observed an influence of the body position on the defecation ability and found that more patients were able to defecate in left lateral body position compared to supine position. The lateral body position may felicitate the defecation process in lying position. This observation is of clinical relevance as most institutions do not have access to an open-configuration MRI. In lateral position, the position of the posterior compartment at rest was significantly lower compared to supine position, whereas the grade of pelvic floor descent was similar in the posterior compartment in the lateral compared to the supine position. Iacobellis et al showed that, compared to the physiological sitting position, pelvic descent at rest can be underestimated in the supine body position at MRD.[30] However, the influence of body position on MRD findings was less pronounced during the defecation phase because the effect of the gravity is dominated by the active effort of defecation. Thus, the difference in grade of pelvic floor descent in sitting *vs* supine position was significant at rest but not during the defecation phase comparable to our results for the posterior compartment.[30]

Regarding the defection ability, a certain influence of the body position has been described previously. Rao et al found that one-third of 25 tested healthy volunteers showed dyssynergia in the lying position whereas when sitting most of the volunteers were able to defecate.[19]

To our best knowledge, this is the first study comparing the IQ of MRD during defecation in supine and lateral position. We found

Table 4. Image quality analysis

	Patients		*p*-value[b]	Volunteers		*p*-value[b]
	Supine	Lateral		Supine	Lateral	
Overall IQ (mean ± SD)						
Rest	4.41 ± 0.50	4.73 ± 0.55	0.071	4.56 ± 0.59	4.59 ± 0.62	0.897
Defecation	4.45 ± 0.36	3.91 ± 0.87	**0.017**	4.38 ± 0.56	4.16 ± 0.73	0.064
Compartments in imaging plane (rest/defecation)[a]						
Grade 3	16/14	15/10		20/20	19/17	
Female	10/8	10/5		11/11	10/8	
Male	6/6	5/5		9/9	9/9	
Grade 2	6/8	6/11		0/0	1/3	
Female	6/8	6/11		0/0	1/3	
Male	–/–	–/–		–/–	–/–	
Grade 1	0/0	1/0		0/0	0/0	
Female	0/0	0/0		0/0	0/0	
Male	0/0	1/0		0/0	0/0	
Grade 0	0/0	0/1		0/0	0/0	
Female	0/0	0/0		0/0	0/0	
Male	0/0	0/1		0/0	0/0	
Posterior compartment in imaging plane[a]						
Rest/defecation	21/20	20/20		20/20	19/17	

IQ, image quality; SD, standard deviation;
Notes: compartments in imaging plane: Grade 3, all compartments; Grade 2, 2 of 3 compartments; Grade 1, 1 of 3 or 1 of 2 compartments; Grade 0, 0 compartments in imaging plane.
[a]Total numbers of patients.
[b]Wilcoxon sign rank test.

slightly degraded IQ during defecation in the lateral body position compared to supine position. This finding was significant in patients, but not in volunteers. A reason for this could be a potentially higher level of anxiety during the exam in patients compared to volunteers—who voluntarily decided to undergo the exam—and thus less cooperation and increased movement affecting IQ. In addition, the need for a more pronounced strain during defecation leads to increased risk for movement artefacts in the volunteers group. This is further underlined by the results of our questionnaire, where the majority of patients preferred the supine position over the lateral position, while volunteers' preferences were balanced. During image acquisition, we noticed that planning of the correct midsagittal plane was more difficult in lateral body position than in supine position as the pelvis may tilt anteriorly in lateral position. During dynamic imaging of the defecation process the pelvis seems to move even more in lateral than in supine position, resulting in more pronounced effects on IQ compared to imaging at rest. To reduce such movement and tilting of the pelvis in lateral body position, a more stable pillow could be placed between the thighs and in front of the abdomen to reduce ventral tilting. Nevertheless, grades of middle and posterior compartment descent were similar in supine and lateral position whereas anterior compartment descent was significantly higher in lateral position. Importantly, patients positioning did not affect whether the posterior compartment was in imaging plane. Only one other study compared image quality of pelvic MRI in different body positions and found no difference in IQ for pelvic MRI performed in supine and prone position.[31]

Study measurements were acquired without difficulty in both positions; however, the majority of patients preferred supine compared to left lateral body position for MRD (not significant). In the group of volunteers, similar numbers of volunteers preferred the supine compared to the left lateral body position. No comparable information is available in the literature; however, unpublished data show that patients have a clear preference for the sitting position when it comes to physiological testing.[32] Further, one previous study found patients' preference for dynamic pelvic MRI in prone position over conventional videoproctography.[33] In general, patient comfort and cooperation is critical. Potential measures to improve comfort and reduce anxiety are pre-examination training on how to perform the MRD manoeuvres and coaching during the exam in order to obtain a viable MRD study. Furthermore, avoiding overdistension of the urinary bladder can also improve patient comfort and quality of the exam.

Our study had certain limitations. First, the study conclusions are limited because of the relatively small number of patients. Second, we focussed on patients with OD and did not include patients with faecal incontinence or healthy controls. This was due to pragmatic considerations. Patients with faecal incontinence are often difficult to examine with MRD, because they cannot hold the rectal enema during the examination until the defecation phase. Further, the patient group was heterogeneous and recruited on the basis of symptoms (*i.e.* outlet obstruction) because no single gold-standard test exists to diagnose OD. As a result, we were not able to calculate the diagnostic performance of MRD in the two body positions for the diagnosis of OD.

In conclusion, in lateral position more patients were able to evacuate with similar grades of pelvic floor descent compared to supine position. Otherwise measurements of pelvic floor structure and function were similar in both positions. It was noted that IQ and patient acceptance was slightly reduced in the lateral position; however, the difference was not considered clinically relevant. MRD in lateral position may be a valuable alternative for patients unable to defecate in supine position.

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